Cryospheric Applications of Landsat-8

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Main Goals

Promote use of Landsat-8 by the polar and glacier communities

Acquire data that supports wide range of science applications

Conduct a series of key studies, validate new and existing algorithms

Demonstrate effectiveness of the Landsat-8 sensors

Acquisition scheme for ice and glaciers

Currrent acquisition format is all land areas, varying priorities;
  – polar coverage is very frequent due to convergence;
  – special requests from PIs or users will be considered;
  – end '*one clear, then next year*' Arctic acquisition plan

Planned ~annual special requests:
Antarctic ascending-node coverage along coast –
Greenland ascending-node coverage along coast –
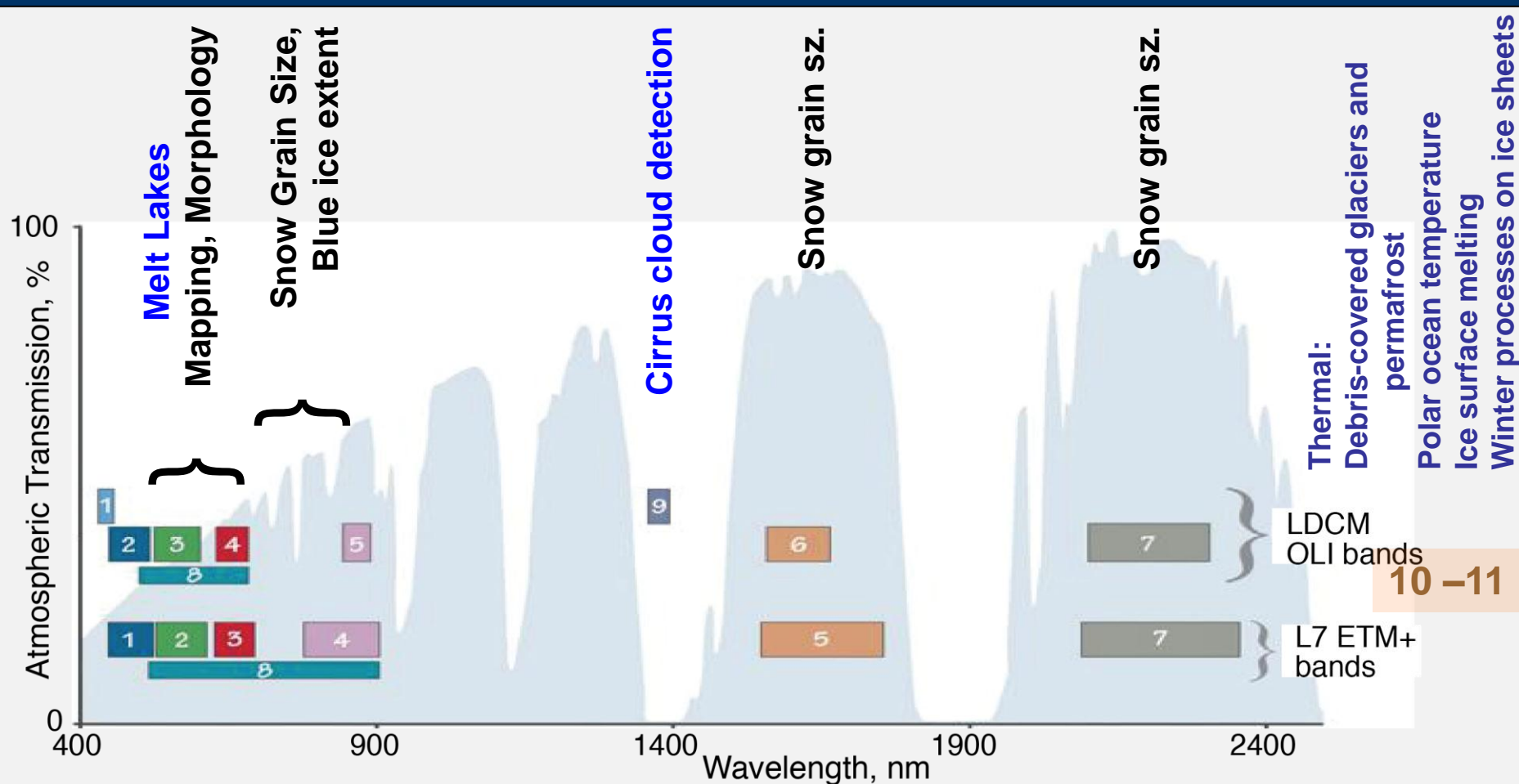   *supporting ice velocity and elevation mapping*

Sea ice study area north of Alaska and Canada (2 areas)

New targets for thermal channel (polar night, ascending node):
  permafrost, debris-covered glaciers, ice sheet coastlines,
  Antarctic winter target for extreme low temperatures.

Snow and Ice and the Landsat 8 bands

B. Markham / NASA GSFC / USGS EROS

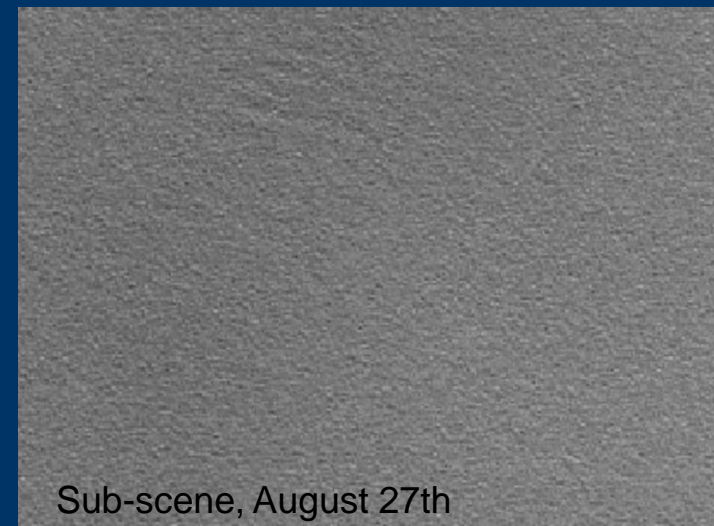# Limits of surface texture detection using L8 Band 8 (pan)

Summit, Greenland, 31 May 2013

7.5 x 9.0 km

Sub-scene, July 28th

No correlation pattern in speckle   6.0 x 4.5 km

Sub-scene, August 27th

Pushbroom noise evident at the several - DN level;

Speckle pattern (±3-4 DN) may be noise or surface snow structures (or both)

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Thermal mapping of the East Antarctic interior in winter
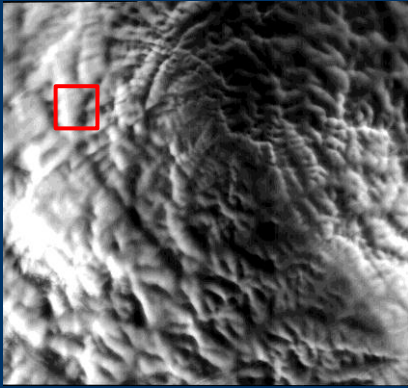
Pushbroom sensor noise in thermal channels at low T is significant;
Destriping filter scheme used to extract noise semi-quantitatively

Path 094, Row 120, 02 June 2013;
near Dome A, Kunlun Station, Antarctica

GGC Sun Oct 27 20:38:00 MDT 2013 Raw.153.B10

Original sub-scene

GGC Sun Oct 27 20:35:36 MDT 2013 NA=19 NB=17 NC=101 153.B10

Extracted noise

Std dev 1.7 K

101   x   17   x   19 filter kernels

GGC Sun Oct 27 20:36:49 MDT 2013 NA=19 NB=17 NC=101 153.B10

Noise-reduced scene

Crippen, PE&RS 1989 filtering (modified)
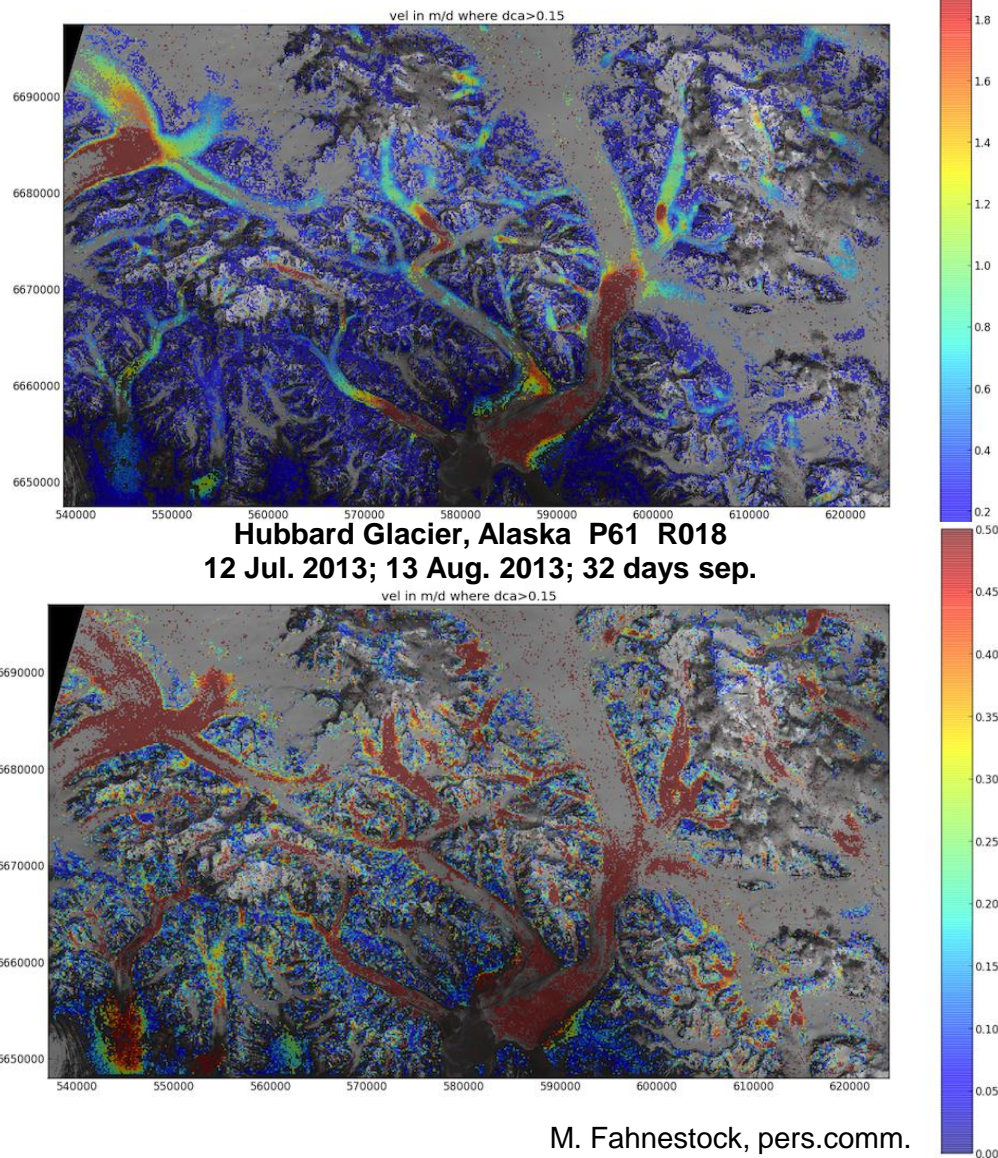
NSIDC

Feature tracking of ice flow

New code makes use of higher radiometric fidelity of L8, and illustrates the high precision of L8 scene geolocation;

Image-to-image cross-correlation applied to ice motion –
Bindschadler and Scambos, 1991;
Scambos et al., 1992;
Fahnestock et al. 1993

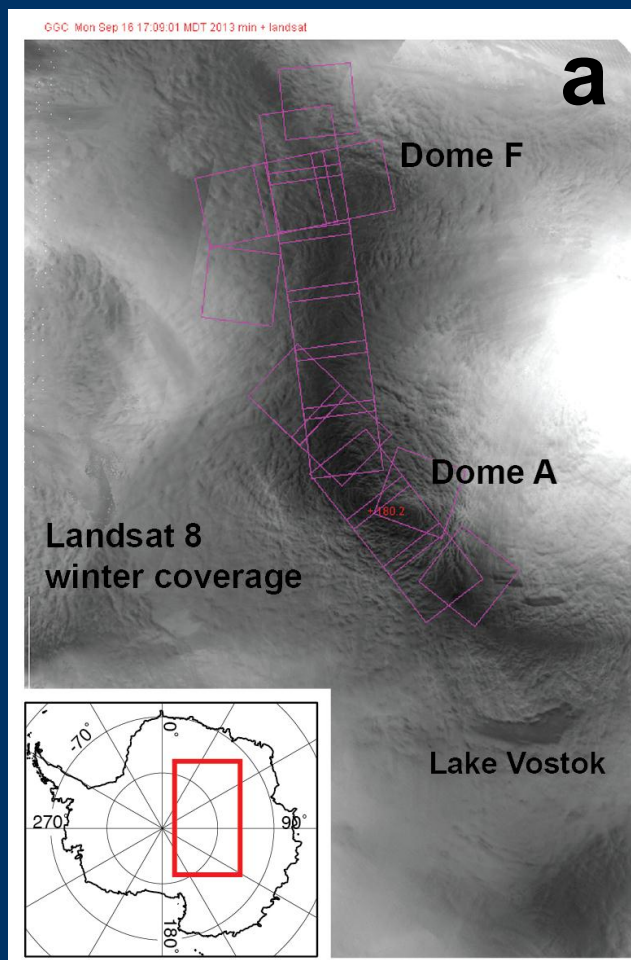Image pair resolves ice motion to 0.3 pixels displacement, or about 5 meters motion;

Implied geolocation accuracy in this case is ~2-3 meters.

Software name: **sPyIce** –

sub-pixel Python Image Correlation Engine.

Hubbard Glacier, Alaska P61 R018
12 Jul. 2013; 13 Aug. 2013; 32 days sep.
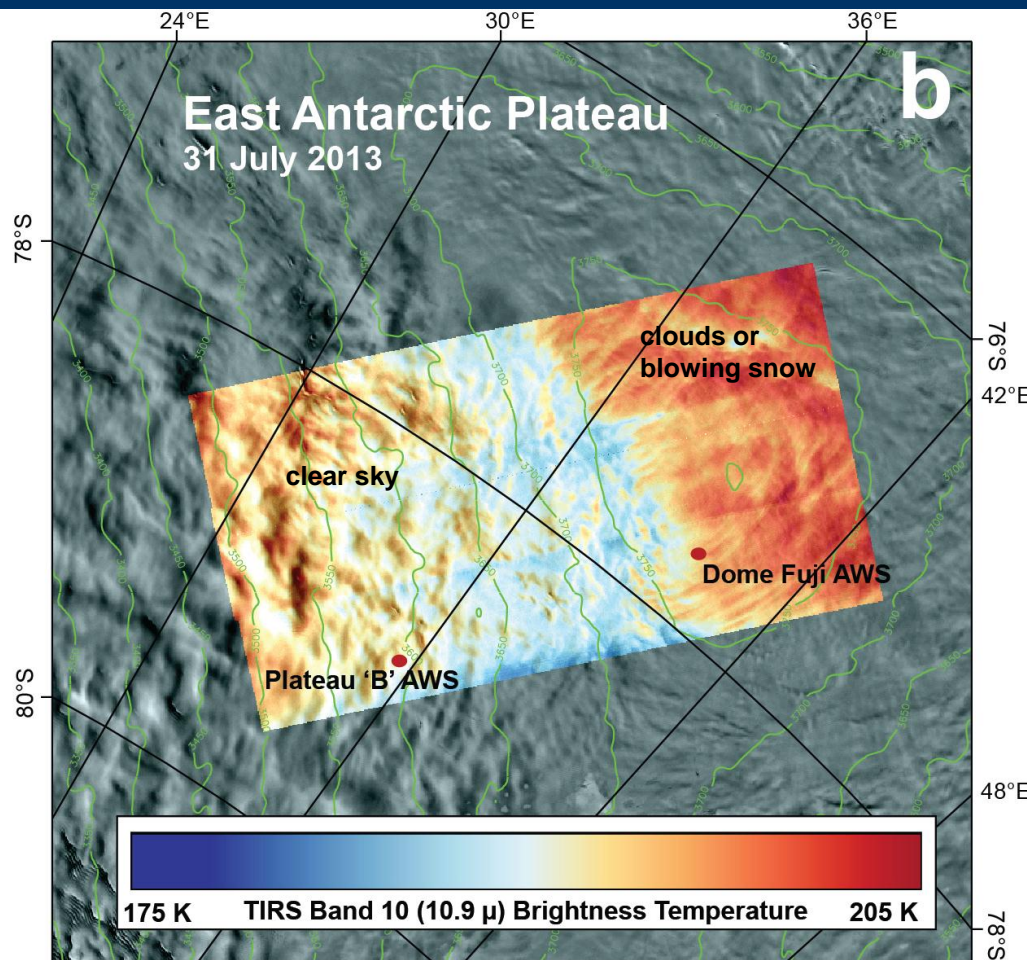
M. Fahnestock, pers.comm.

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Thermal mapping of the East Antarctic interior in winter

MODIS LST minimum T, 2013

surface image with Landsat 8 B10 color scale BT

Purple outlines are Landsat 8 acquisitions June-August 2013

Thermal mapping of the East Antarctic interior in winter

Cold mid-winter temperatures occur near an ice divide crest under clear-sky conditions;
Radiative surface cooling, and light winds; coldest temperatures occur in ~2-4 km wide hollows
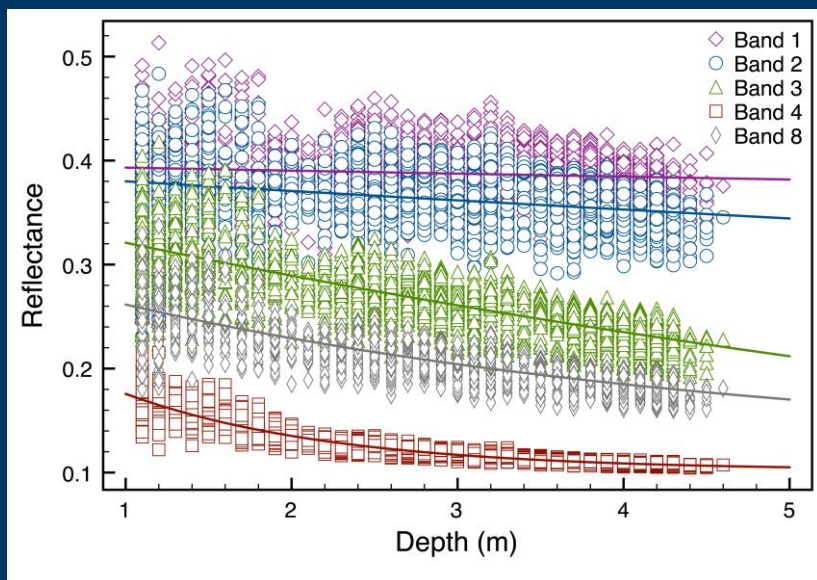caused by ice flow and wind erosion.

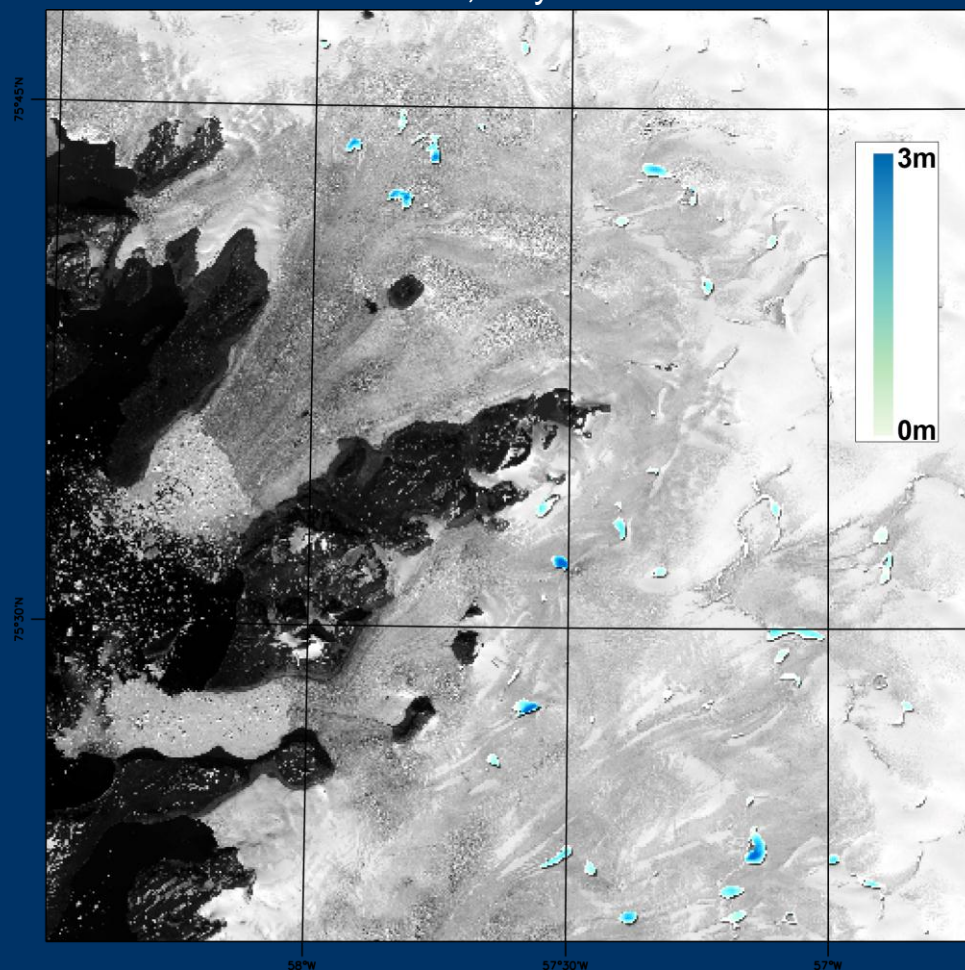## *MODIS Aqua 'night' Land Surface Temperature (blue = < 190 K)*

| 19 July | 21 July | 28 July | 31 July |

Purple outlines are Landsat 8 acquisitions June-August 2013

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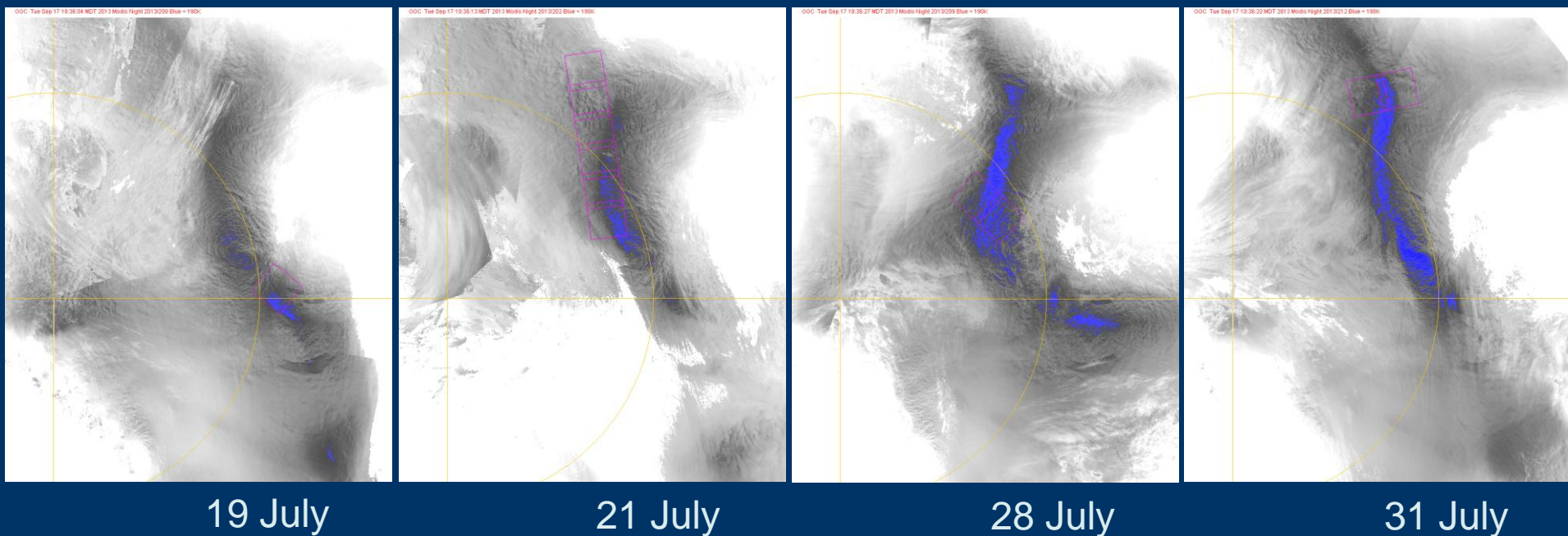
Melt lake depth mapping using Landsat 8

Field data emulation of OLI bands:

northwestern Greenland, July 18 2013

Two approaches:
    extinction in single band (gr, B3, pan band, B8)
    band ratio (coastal, B1, and green, B3)

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Glacier extent/ flow/ change analysis: Altai, Mongolia, and north-central Asia

North-central Asia glacier region is relatively under-studied for glacier change

- Collaborators have used Landsat archive to map extents, 1970 – 2003;

- new work with Landsat 8 will re-map extents, glacier facies, and ice flow.

- We are evaluating the overlap of glacier ice with ICESat laser altimetry in this region.
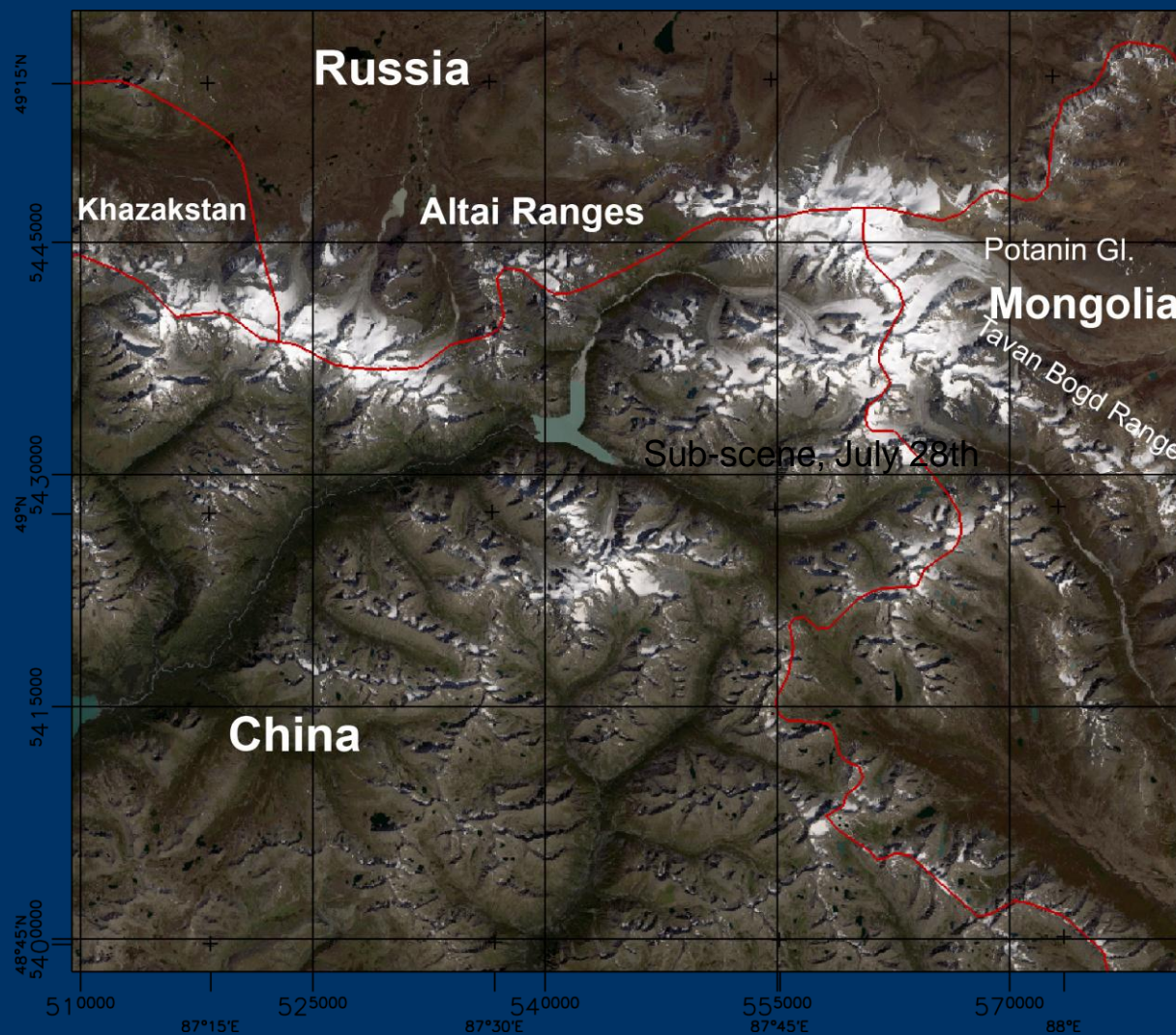
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Landsat-8 Cryosphere group

• **Ted Scambos (PI) is a Senior Research Scientist at NSIDC, a part of University of Colorado;** ice sheet mapping, polar field geophysics, climate change in polar regions, sea ice processes

• **Allen Pope**, **post-doc now at NSIDC;** spectral mapping of mountain glaciers; polar remote sensing

• **Robert Bindschadler (Co-I, contractor) is an emeritus scientist for NASA** affiliated with the Cryospheric Sciences group at GSFC

• **G. Garrett Campbell,** Research Scientist, NSIDC
• **Terry Haran,** senior programmer and geospatial mapping, NSIDC
• **Mark Fahnestock,** Research Professor, UAFairbanks
• **Marin Klinger**, planned new hire for VELMAP processing

Questions?

Potential LDCM studies

Snow grain size and blue ice extent on ice sheets from LIMA / MOA

Morphology of ice sheets and ice shelves
 (comparison of 'sensitivity' to past sensors)

Feature tracking w/ Landsat legacy comparison

Lake extent, depth, and volume in western Greenland / AP

Image differencing and sub-ice-sheet water movement

Photoclinometry / shape-from-shading at grounding line and
 interior undulation

Thermal mapping of polar ice sheets, winter inversion layer,
 ocean SST at the ice fronts.